

Physics 30X

1967



HIGH SCHOOL AND UNIVERSITY MATRICULATION
EXAMINATIONS BOARD

DEPARTMENTAL EXAMINATIONS, 1967

PHYSICS 30X

Time — 3 hours.

DO NOT SPEND TOO MUCH TIME ON ANY ONE QUESTION.
READ THE QUESTIONS CAREFULLY.

Total Possible Marks — 139.

Note—Mathematical tables will be supplied by the presiding examiner.
Slide rules may be used.

Use the following constants where they are required:

$$g = 10 \text{ m/sec}^2$$

$$1 \text{ coulomb} = 6.24 \times 10^{18} \text{ elem. ch.}$$

$$1 \text{ volt} = 1.6 \times 10^{-19} \text{ joules/elem. ch.}$$

$$\text{Avogadro's number} = 6.02 \times 10^{23}$$

Constant in Coulomb's law:

$$K = 9.0 \times 10^9 \frac{\text{newton-m}^2}{(\text{coulomb})^2}$$

Constant for determining the magnetic field due to a current
in a straight wire.

$$K = 2 \times 10^{-7} \frac{\text{newtons}}{(\text{amp})^2}$$

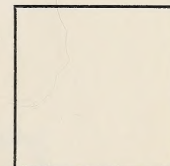
When diagrams are drawn to scale, the scale used should be clearly
indicated.

Rough work and diagrams may be done in pencil. Finished work
may be done in either soft pencil or blue or black ink (pen or
ballpoint).

DO NOT FOLD THIS BOOKLET.

Place your test booklet in the answer envelope in such a way that
the **UPPER LEFT HAND CORNER OF THE BOOKLET** (Candi-
date's Number) shows through the **SLASHED CORNER** of the
answer envelope.

BE SURE TO SEAL THE ENVELOPE.



(For the use of Sub-
Examiners only)

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CURR HIST

Values

SHOW COMPLETE SOLUTIONS FOR THE FOLLOWING PROBLEMS:

- 2 **1.** A high speed photograph of a moving bullet was taken by means of a flash of light which lasted one-millionth of a second. If the velocity of the bullet was 500 m/sec, how far did it travel while the light was on?
- 2 **2.** A man walks in a direction 30° N of E at 4.0 mph. What is the northward component of his velocity?

FOR ROUGH WORK

(No marks given for work in this space)

Values

2 3. A student weighed 8 steel spheres and found that each one weighed 9.64 gm. Express the total weight of the 8 spheres giving close attention to significant figures.

3 4. A train on a straight section of track accelerates uniformly from a speed of 5.0 m/sec to 15.0 m/sec while travelling 2.0 km. Express its acceleration in meters per second per second.

FOR ROUGH WORK

(No marks given for work in this space)

[OVER]

Values

- 2 5. A ball is thrown vertically upward with a velocity of 25 m/sec. How high will it rise above the point from which it is thrown near the earth's surface. Neglect air resistance.
- 3 6. Body A and body B start from rest and are accelerated for the same length of time by equal forces which act on them. At the end of this time body A is going 10 m/sec and body B is going 12 m/sec. If body A has a mass of 120 gm, what is the mass of body B?

FOR ROUGH WORK

(No marks given for work in this space)

Values

- 3 7. A 1000 kg car accelerates uniformly from a speed of 15 m/sec to a speed of 25 m/sec while it travels a distance of 80 m. How much momentum does it gain during the 80 m trip?

- 3 8. How much kinetic energy is gained by a 100 kg body which falls freely for a distance of 8.2 m near the earth's surface?

FOR ROUGH WORK

(No marks given for work in this space)

[OVER]

Values

- 3 9. A car driver drives around a circular track at 20 mph and finds that the centripetal force on him is 12 newtons. How much centripetal force will he experience if he drives around the track at 50 mph?
- 3 10. A certain spring stores 40 joules of energy when it is compressed from its normal length of 20 cm to a length of 12 cm. How much energy is stored in the spring when it is compressed to a length of 16 cm?

FOR ROUGH WORK

(No marks given for work in this space)

Values

- 3 11. The kinetic energy of center of mass motion of the molecules of a certain enclosed volume of a gas is 20 joules when its temperature is 27°C . How much kinetic energy of center of mass motion will its molecules gain if its temperature is raised to 77°C ?

- 3 12. A 0.24 kg ball moving at 32 m/sec strikes a brick wall perpendicularly and rebounds with a velocity of 28 m/sec.. How great an impulse does the ball give to the wall?

FOR ROUGH WORK

(No marks given for work in this space)

[OVER]

Values

- 2 **13.** If 2.0×10^{20} electrons pass a given point in a metal conductor in 2.0 sec, express the current in amperes.

- 3 **14.** The strength of the electric field between two charged flat metal plates is 4.0×10^3 newtons/coulomb. If the potential difference between the plates is then doubled and the distance between the plates is halved, what does the field strength become?

FOR ROUGH WORK

(No marks given for work in this space)

Values

- 2 **15.** Two electrified objects A and B are 2.0 cm apart. Object A experiences a force of 4.0×10^{-5} newtons due to the presence of B. If A and B are moved until their separation is 6.0 cm, what is the force on A in this new position?

- 2 **16.** A 45 volt battery sends a current of 2.0 amp through a resistor, what power is dissipated into heat in the resistor?

FOR ROUGH WORK

(No marks given for work in this space)

Values

- 2 17. A rectangular coil of wire is rotated in a magnetic field producing an average EMF of 1.0 volt. If the magnetic field strength is doubled and the rate of rotation of the coil is also doubled, what average EMF is now produced?

FOR ROUGH WORK

(No marks given for work in this space)

Values

- 18.** A navigator wishes to fly from point A to point B which is 800 mi away from A in a direction 45° W of S. A wind is blowing directly from the east at 60 mph.
- 4 (a) If the navigator plans to maintain an airspeed of 180 mph, what heading should he give the airplane?
- 3 (b) How long will it take to make the trip?

FOR ROUGH WORK

(No marks given for work in this space)

Values

- 5 **19.** Two moving cars, A and B, applied their brakes at the same time and decelerated at the same rate. At the instant their brakes were applied, car A was travelling at a speed of 21 m/sec and car B at 15 m/sec. Car B required 5.0 sec to stop after the brakes were applied, how far did car A travel after car B stopped?

FOR ROUGH WORK

(No marks given for work in this space)

Values

- 20.** A heavy object was dropped from a high bridge into water which lay below. It was observed to take 3.0 sec to complete the fall. Air resistance was negligible.

2 (a) What was the average velocity of the object during the fall?

4 (b) What was the velocity of the object when it was half way down?

FOR ROUGH WORK

(No marks given for work in this space)

Values

- 4 **21.** How great would be the force of attraction exerted by the sun on a 2.0×10^3 kg satellite moving around it in circular orbit once every 20 hr at a distance of 2.6×10^9 m from the sun's center?

FOR ROUGH WORK

(No marks given for work in this space)

Values

- 4 **22.** During the performance of an experiment two loaded dynamics carts started from rest on a level table top and moved apart due to the thrust of a spring suddenly released between them. One of the carts which with its load weighed 4.5 kg went 110 cm in a certain length of time. How far should the other cart, which with its load weighed 6.0 kg move in the same time interval?

FOR ROUGH WORK

(No marks given for work in this space)

Values

- 23.** A 2.0 kg block started from rest and slid under the influence of gravity for a distance of 3.0 m downward along a 45° slope. At the end of the 3.0 m trip the block was going 4.0 m/sec.
- 5 (a) How many calories of heat were generated by the sliding block during the 3.0 m trip?
- 4 (b) How great was the force of friction resisting the motion of the block as it slid along the surface?

FOR ROUGH WORK

(No marks given for work in this space)

Values

- 7 **24.** A 10 gm glass ball at rest on a horizontal surface was struck by a 30 gm steel ball which was rolling due northward with a speed of 4.0 m/sec. The glass ball then went 40° E of N with a velocity of 3.0 m/sec. What was the speed and direction of the steel ball after the collision?

FOR ROUGH WORK

(No marks given for work in this space)

[OVER]

Values

- 4 **25.** A, B, and C are charged bodies carrying charges of $+2$, -2 , and $+8$ units respectively. A and C are fixed 100 cm apart. Where must B be placed in order to experience no net electrostatic force?

FOR ROUGH WORK

(No marks given for work in this space)

Values

- 26.** A long straight wire carrying a current is perpendicular to an independent magnetic field of strength 5.0×10^{-5} newtons/amp-m.
- 3 (a) What current must pass through the wire to produce zero field strength at a point 4.0 cm from the wire and in the region of the independent magnetic field?
- 2 (b) With the aid of a diagram show the location of a point with zero field strength.

FOR ROUGH WORK

(No marks given for work in this space)

Values

- 4 **27.** Calculate the acceleration of an electron in an electric field of intensity 5.0×10^2 newtons/coulomb.

FOR ROUGH WORK
(No marks given for work in this space)

Values

- 28.** A metal bar 50 cm long is totally within and perpendicular to a magnetic field of 0.80 newtons/amp-m. It is pulled across the magnetic field at a speed of 50 cm/sec in such a direction as to induce the maximum EMF.

- 4 (a) Calculate the value of the induced EMF.
- 4 (b) If the bar has a resistance of 0.20 ohms, what force is needed to keep it moving through the field with the same speed and direction?

FOR ROUGH WORK

(No marks given for work in this space)

[OVER]

Values

- 8 **29.** A singly charged ion is accelerated through a potential difference of 900 volts. It then enters at right angles a magnetic field of strength

$$2.0 \times 10^{-20} \frac{\text{newtons}}{\left(\frac{\text{elem. ch.}}{\text{sec}} \right) - \text{meter}} . \text{ What is the radius of its circular path}$$

if the mass of the ion is 2.0×10^{-26} kg?

FOR ROUGH WORK

(No marks given for work in this space)

Values

ANSWER QUESTIONS 30 TO 37 BY WRITING CLEAR STATEMENTS IN THE SPACES PROVIDED.

- 2 **30.** The sum of two vector quantities that are equal in magnitude can be zero. Explain how this is possible.

- 2 **31.** Explain why a 10 lb ball of lead falls at about the same rate as a 1 lb ball of lead when the two are dropped from the same height even though the force of gravity on the large one is ten times as great.

- 3 **32.** Describe the apparent center of mass motion of the earth as viewed from a satellite making a circular orbit around the earth. Assume that the satellite keeps the same side toward the earth at all times.

[OVER]

Values

- 8 **33.** A body hangs suspended at the end of a coiled spring and moves up and down with simple harmonic motion. Indicate the energy changes which take place in the system by writing in each blank space in the chart below whether there is a DECREASE, an INCREASE, or NO CHANGE in the energy identified in each case. Neglect the small amount of energy converted to heat.

	(a) Gravitational Potential Energy	(b) Potential Energy in the Spring	(c) Kinetic Energy of the Body	Total of (a), (b) & (c)
As the body rises from its central position to the highest point reached				
As the body falls from its central position to the lowest point reached				

- 3 **34.** You are supplied with two identical metal spheres, A and B, mounted on insulating stands. A is negatively charged and B is neutral. Explain step by step (with the aid of diagrams) how you reduce the charge on A to exactly one-quarter of its original value.

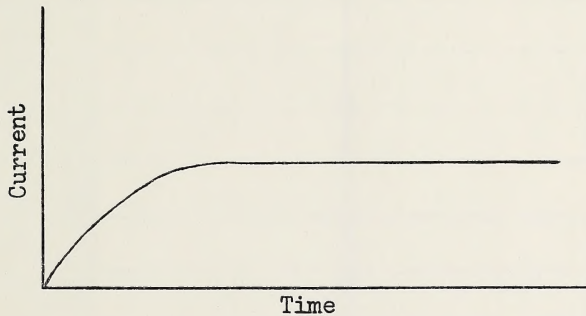
Values

- 2 **35.** What physical property of a metal is measured in amperes per volt-meter.

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- 3 **36.** The graph below shows how the current through a coil changes with time as it is switched on. Explain the cause of the characteristic shape.



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- 2 **37.** State briefly the essential difference between the conduction of electricity through metals and conduction through ionized solutions.

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